CHEAP, DO-IT-YOURSELF METHOD TO ESTIMATE I/I USING PLANT FLOW MONITORING REPORTS

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I/I: A PROBLEM FOR MUNICIPALITIES

- PRESSURE FROM VARIOUS SOURCES (EPA, PUBLIC, BUDGET) TO REDUCE I/I & OVERFLOWS
- I/I REPRESENTS MORE THAN 20% OF FLOWS TREATED BY LARGE SYSTEMS IN REGION 4 *
- LIMITED FUNDS
- COST (PERCEIVED) OF FLOW MONITORING

? Is there a tool they can use to diagnose their own system ?

* Kurz & Qualls, WEFTEC 2001

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OUTLINE

- Small city – before & after rehabilitation
- Transformation of raw DMR data
- Statistical analysis using modified "Standardized Procedures" *
- Comparison between results based on simulated daily flows and actual hourly flows

* Kurz, et al, WEFTEC 2003

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USING MR's FOR EVALUATING I/I

- DMR – Discharge Monitoring Report – required monthly by NPDES Permit – usually contains monthly averages, max & min, but no rainfall
- MOR – Monthly Operating Report – more detail, usually daily information on flows and rainfall
- Publicly available information

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SMALL CITY EXAMPLE *

BELL BUCKLE, TN:

- Population ~400
- Treatment capacity 150,000 gpd

- CDBG Rehabilitation Project
- Sewer line slip lining
- Manhole repair

* Ward, MTAS 2007

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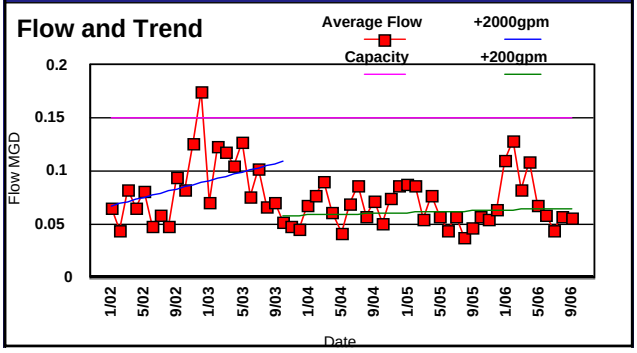
DMR FLOWS – BEFORE & AFTER



I/I INDICATIONS FOLLOWING REHAB

- Wet season flows appear to be reduced following rehabilitation work
- Difficult to quantify
- What is the relationship to rainfall ?
- Is the result influenced by annual rainfall variation ?
- What level of confidence can be determined ?

CHECK THE DAILY FIGURES IN THE MOR !

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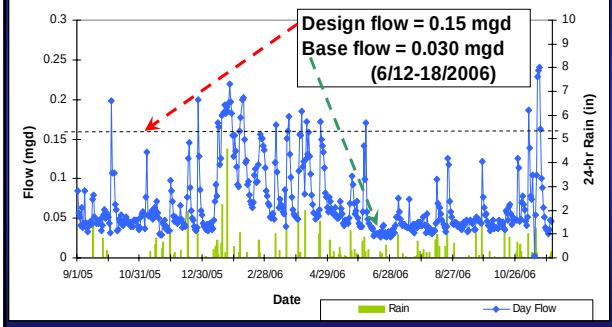
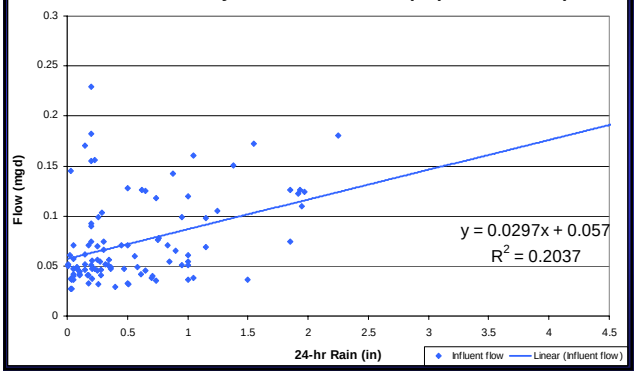
Bell Buckle Daily Influent Flow



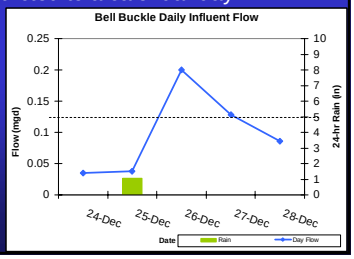
Bell Buckle Daily Influent vs Rainfall (Sep '05 - Nov '06)



EVALUATION

- Poor correlation (r^2 ~ 0.20) - almost worthless !
- One possible problem is that the duration of each "step" is 24 hours – restricted to a calendar day

Example: rainfall occurs at the end of one day, but the I/I begins to influence the plant the next day



MODIFIED APPROACH

- Create a transformed data set
- Each new "rain" entry will be the sum of the rain that day plus the previous actual day
- Each new "flow" entry will be the actual day flow minus the actual flow two days previously
- Use peak flow entry for a given rain event

	ORIGINAL		TRANSFORMATION	
Date	Rain	Influent	2-day rain	2nd day RDII
12/23		0.036	0	
12/24		0.035	0	
12/25	1.05	0.038	1.05	0.002
12/26		0.2	1.05	0.165
12/27		0.128	0	
12/28		0.086	0	

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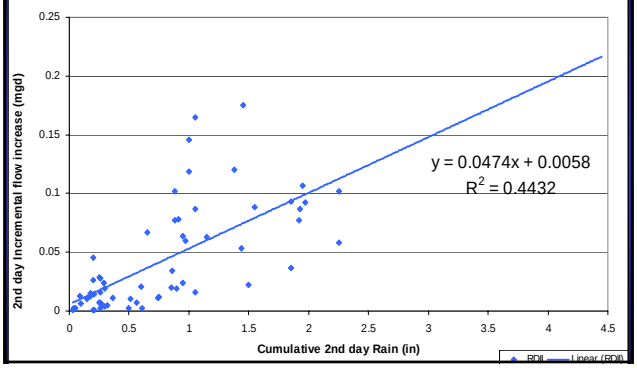
Bell Buckle Rainfall Dependent I/I Flow (Sep '05 - Nov '06)



ANALYSIS OF DAILY PLANT FLOWS
(Sep 2005 – Nov 2006)

0.069		Average plant flow (gross average of all days)
31.335		Total plant flow in period
0.030		ADF - Base Flow (average of 7 lowest consecutive days)
17.590		I/I in period (Total flow minus base flow for period)
0.295		I/I per inch rain (I/I divided by period rainfall)
13.934		Normalized I/I per year (I/I for 365 days for annual average rain)

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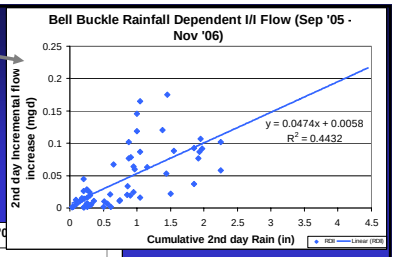
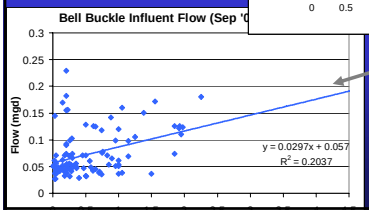
Better

Estimate of RDII using cumulative rainfall and incremental increase of influent flow – more realistic projection of I/I and has better correlation factor





Basic Graph

Plot of daily flow related to daily rainfall – poor correlation factor

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RAW vs TRANSFORMATION

	5-YEAR PROJECTED I/I	R^2
RAW	0.161 *	0.20
TRANSFORMED	0.219	0.44

* 0.1906 from graph, minus 0.030 base flow
(to isolate the increase due to rainfall)

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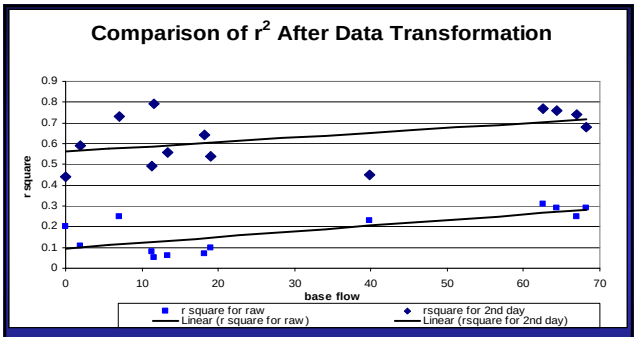

FOR 9 TREATMENT PLANTS (13 Years of data):

Average raw r^2 = 0.176,

r^2 for transformed data = 0.629 - 3.6x improvement

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REFINING THE RESULTS

Since we are projecting I/I values out to a design rainfall event (i.e. 5-year recurrence interval), what is the level of confidence in the projected number?

Try using a statistically based method – similar to the "Standardized Approach" * used for analyzing sewer flow monitoring data.

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* Kurz, et al, WEFTEC 2003

STANDARDIZED APPROACH
(summary highlights)

- **DESIGN STORM (e.g. 5-YEAR, 24-HOUR EVENT)**
- **STATISTICAL CRITERIA FOR QA/QC**
- **DEFINE RAINFALL EVENT (e.g. 10 HRS DRY PREV.)**
- **USE MAXIMUM NUMBER OF EVENTS IN PERIOD**
- **MINIMIZE ANALYST BIAS (SELECTIVITY)**

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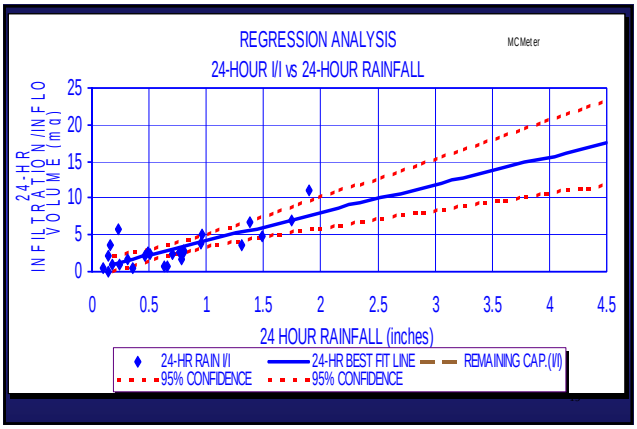

CHECK VALIDITY

How do the results for this estimating procedure compare with the results from metering data reported on an hourly basis ?

Test: Use hourly data from a gravity flow meter, convert the data into daily average flows and daily total rainfall. Analyze the daily numbers and compare to I/I results derived from the original hourly analysis.

Used data from “Site 7” for the following example:

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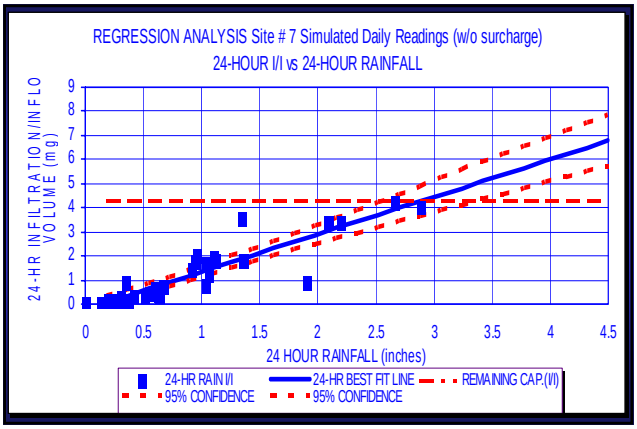

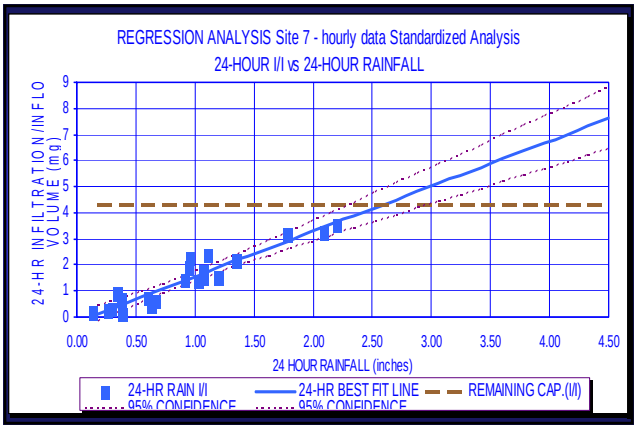

COMPARISON OF ESTIMATE TO ACTUAL STANDARDIZED RESULTS

	Projected I/I (MG for 24 hrs, 5-yr event	r^2
All Raw Data	6.38 (-0.5 base = 5.88)	0.49
Oct-Apr	7.998	0.66
Transformed	6.784	0.83
Standardized Hourly Data	7.694	0.90

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CONCLUSIONS

- Existing plant influent data (DMRs & MORs) can be used for estimating I/I, thus minimizing costs for initially estimating the extent of I/I problems in the community.
- A simple data transformation improved the r^2 correlation by an average of 3.6x for I/I estimation using 24-hour data
- Evaluation of daily flow & rainfall data achieved an estimate within ~11% of hourly data
- Estimates may be on the low side, due to peak flow attenuation, restrictions and losses in the lower reaches of a sewer system

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